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EFFECTS OF REWARD DISTRIBUTION AND PERFORMANCE FEEDBACK ON COMPETITIVE RESPONDING

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To implement competitive contingencies, one must select a distribution of unequal rewards and a schedule of feedback for competitors regarding one another's performance. This study investigated three bases for distributing rewards and two performance feedback conditions. Pairs of college students competed over a series of 2-min contests in which the competitive response was a knob pull. A sum of money was divided using a proportional distribution or one of two fixed reward distributions. In the proportional distribution, a subject's proportion of the sum was his or her proportion of the total number of responses. The two fixed distributions were divisions of 100%/0% or 67%/33%. Also, in every contest either subject could make a response that would end the contest prematurely and give both subjects the same amount—a sum equal to 33% of the competitive total. In the two feedback conditions, cumulative responses by each subject were either shown to both subjects during the contest or were not shown. The proportional distribution was clearly superior to either of the fixed distributions in number of responses produced across contests. The proportional distribution with feedback produced the largest number of competitive responses, and the 100%/0% distribution without feedback produced the smallest number. Differences among distributions typically emerged only during later blocks of contests. Fixed distributions of rewards often produced decelerating rates of responding, with losing competitors ending the contests before they were completed. Response-rate decreases were greatest for pairs in which the 2 subjects differed most in their response rates and proportion of wins. The presence of feedback had a small effect, increasing responding for some pairs in the 100%/0% distribution. Performance patterns were interpreted in terms of the consequences arranged for the individual participants by the reward distributions and differences in performance between competitors.

Key words: competition, reinforcement contingencies, reward distributions, performance feedback, knob pull, college students

One of the most basic and enduring issues in human relations has been ways in which people organize to undertake tasks most productively. Assuming that rewards are available, how should they be dispensed to produce the best total effort *by the group* (e.g., problems solved, products produced or sold, academic materials learned, etc.). Interest has focused on two forms of organization: cooperation and competition. The key element in a cooperative contingency is mutual reward (Marwell & Schmitt, 1975). All participants receive rewards (although not necessarily equal) if their performances meet a specified criterion. With a competitive contingency, rewards are distributed unequally based on relative performance. Both cooperation and competition incorporate reward interdependence. The rewards received by participants are positively correlated under cooperative contingencies and negatively correlated under competitive contingencies. Cooperative and competitive contingencies are often compared with a third alternative, an individual contingency, under which interdependence is absent (a reward is received when an individual performance criterion is met).

A large body of social science research has compared these three kinds of contingencies (most often cooperation and competition) with regard to performance (for reviews see Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Miller & Hamblin, 1963; Qin-Zhining, Johnson, & Johnson, 1995; Rosenbaum, 1980; Schmitt, 1981, 1984; Slavin, 1977, 1983). In general, results emphasize the advantages of cooperation. In particular, cooperation is effective across a range of tasks, whereas competition is effective only when task responses can be made independently by each person, with little or no col-

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laboration required by those working on the task. When competition is an option, though, it is often more cost effective (more responses made per unit of reward), easier to implement, and can produce short-term performance rates that are higher than those of the other conditions (Schmitt, 1987). Various conditions have also been found to increase competitive performance. These include situations in which people cannot easily withdraw from competitive tasks and ones in which competitive and individual contingencies are combined (Schmitt, 1987). Thus, competitive performance varies greatly, depending on contest conditions. Surprisingly, however, little research has systematically studied the effects of basic features of competitive contingencies on performance. This study investigated two major variables: reward distribution and performance feedback.

Whenever competitive contingencies are implemented, a distribution of unequal rewards must be established. Distributions can be created in either of two basic ways. The first way is to base the distribution on the relative performances of the competitors—a proportional distribution. Each person's proportion of the total group reward equals that person's contribution to the total group output. The second way is to set the proportions of the total group reward in advance—a fixed distribution. In this case two properties must be considered. One is the proportion of competitors who will receive rewards in each contest. At one extreme, only one competitor receives a reward; at the other extreme, all competitors are rewarded, but in varying amounts. The latter is tantamount to giving a reward to each competitor that is not contingent on performance—specifically, that amount received by the lowest performer. These minimal amounts have been termed *global incentives* in labor economics (O'Keeffe, Viscusi, & Zeckhauser, 1984). Maximizing the proportion of competitors rewarded should encourage poorer performers to remain in contests. When more than one competitor is rewarded, variation can occur in a second property, reward differential or spread, which is the difference between the highest and lowest reward amounts in each contest. Maximizing reward differential should more highly motivate those who have a chance of winning. The proportion of competitors who receive at least some reward affects the size of the differential possible, given that total reward remains constant. The larger the proportion of competitors receiving at least some reward, the smaller the maximum differential can be.

A second element arises when a given contest consists of cumulative responses over time (e.g., a sales contest, golf match) or when contests are repeated with the same contestants (e.g., a series of tests graded on a curve in a course). Here competitors can be provided with feedback during or between contests with regard to their own and others' performances, or they can be denied such feedback (although receipt of the reward itself necessarily provides some feedback). If feedback is provided, it can be ongoing or intermittent. Performance feedback should function as a discriminative stimulus that serves to increase or decrease a competitor's responding (for an extended discussion see Schmitt, 1986). For example, feedback that reveals nearly equal performances by competitors signals that an increase in performance is likely to improve chances of reward. Feedback that reveals markedly unequal performances signals little chance of reward for the poorest performers, regardless of their performance. They should be likely to quit competing or quit the contest. Halisch and Heckhausen (1977) found that subjects were less likely to seek information about competitors as performances became more unequal. Overall, feedback seems likely to produce greater performance variability among competitors and increase the sensitivity of competitors to differences in reward distributions.

The present study investigated three bases for distributing rewards and two conditions that varied feedback regarding number of competitive responses during contests. Pairs of subjects in separate rooms competed over a series of 2-min contests in which success in each contest depended on making the larger number of knob pulls. A sum of money was divided between the participants using either a proportional distribution or one of two fixed reward distributions. In the proportional distribution, a subject's portion of the sum was the proportion of total number of knob pulls made. The two fixed distributions varied the degree of inequality in the portions of the sum received by the winner and loser. An extreme distribution in which the winner's portion was 100% was contrasted with a more nearly equal distribution in which the winner's portion was 67% and the loser's was 33%. At any time, either subject could also make a response that would end the contest. If that response was made, each subject received an individual amount equal to 33% of the competitive sum. In the feedback condition, computer screens displayed cumulative pulls by each subject during the contest. In the no-feedback condition, they did not. Thus, six conditions were investigated: each of the three distributions with and without feedback (pulls shown or not shown). Each contest condition was repeated 15 times over five 1-hr sessions.

METHOD

Subjects

Eighteen college students (10 female, 8 male) were recruited to participate in a laboratory study through notices read in undergraduate classes. The notice stated that the study would consist of five 1-hr sessions, and that subjects would earn between $6 and $12 per hour. Subjects signed consent forms agreeing to be available for the required sessions. Forms stated that contest earnings would be paid after each session, and that an extra $2.50 each day would be paid after the last session.

Apparatus

Each of the two experimental rooms contained a table with a monochrome video monitor and a panel (24 cm by 43 cm) with stimulus lights and a button for ending the contest. A plunger with a return spring (Lindsley knob) mounted below the panel required a pull of approximately 600 g. Instructions, number of pulls, and point amounts were displayed on the monitor. A red light in the upper right corner of the panel (labeled ''Panel On'') was lighted when a contest was in effect. When a subject pulled the knob, a light in the center of the panel was illuminated for 0.1 s. The button used to end a contest, labeled ''Stop Contest,'' was located in the lower left corner of the panel. An amber light above the button, labeled ''Competition On,'' was illuminated during a contest, unless the contest was stopped by a subject.

Table 1

Sequence of conditions.

Session	Contest	Distribution	Pulls shown?
1	1	Proportion	Yes
	2	100%/0%	Yes
	3	67%/33%	Yes
	4	100%/0%	No
	5	Proportion	No
	6	67%/33%	No
	7	67%/33%	Yes
	8	100%/0%	Yes
	9	Proportion	Yes
	10	Proportion	No
	11	67%/33%	No
	12	100%/0%	No
	13	100%/0%	Yes
	14	67%/33%	Yes
	15	Proportion	Yes
	16	67%/33%	No
	17	Proportion	No
	18	100%/0%	No
2–5	Order of the three distributions was varied within three-contest blocks, and pulls shown and pulls not shown were alternated every three contests.		

Procedure

Subjects worked in same-sex pairs. Subjects reported to separate waiting areas and were dismissed separately in order to avoid contact during the experiment. Table 1 shows the sequence of conditions for the five sessions. At the beginning of the first session, the following instructions for the proportional distribution were displayed on each subject's screen:

> Amount in this contest: 80 cents. Division is based on % of total pulls made by each person. If you stop this contest, you each get 26 cents.

The experimenter then read the following instructions separately to each subject:

> You will be competing with another person. There will be a series of contests each lasting 120 seconds—2 minutes. The amount that can be won in each contest is shown on the screen [experimenter pointed to amount]. The person who pulls the knob the highest number of times during a contest wins the most money. How the money is divided is shown on the screen [experimenter pointed to statement of amount on the screen]. This means that if you pull 150 times and the other person pulls 50 times, you will get three times as much as the other person—60 cents versus 20 cents. Once

> the contest begins, you can end it at any time by pressing the red button. The competition light will go out and you must wait until the contest ends—a total of 120 seconds. Then each of you will get 26 cents [experimenter pointed to statement of amount on the screen]. Now you will get various conditions until the end of the session.

When the contest was started, three ongoing messages were displayed simultaneously on the screen. The first stated ''Contest in progress. Based on % of total pulls.'' The second stated ''A's pulls— and B's pulls—'' with the number of pulls shown for each subject. The third stated ''Time Remaining—'' and counted down from 120 s in 5-s intervals. The number of pulls was updated every 5 s. The second message was omitted during periods in which pulls were not shown (no feedback).

At the conclusion of the contest, the ''Panel On'' light went off. If neither subject had stopped the contest and at least 1 subject had made a pull, 80 cents was divided between the subjects, based on proportion of total pulls. A message on the screen stated the number of pulls by each subject, percentage of total pulls by each subject, and each subject's earnings from that contest. This message was included in all contests (with or without feedback). It remained on the screen for 20 s, and was followed by the message initiating the next contest. If neither subject pulled, no earnings were received. If either or both subjects stopped the contest, a message on the screen instructed each subject to pull the knob once. Pulling the knob registered 26 cents on the subject's screen.

For contests with fixed distributions, the message before the contest stated either ''Winner gets 100%. Loser gets nothing,'' or ''Winner gets 67%. Loser gets 33%.'' As with the proportional distribution, screen messages during the contest stated the distribution in effect, time remaining in the contest, and the number of pulls (during contests with feedback). If contests with fixed distributions ended in a tie regarding number of pulls, 1 subject was programmed as the winner. The other subject won in the case of a second tie (no ties occurred under fixed distributions).

Following each block of three contests (which included the three distributions and the same feedback condition), the screen went blank for 30 s before the message initiating the next contest appeared.

At the conclusion of the experiment (after Session 5), subjects answered written questions. The first asked if they knew their partner or talked to him or her. Others asked which one of the six conditions they most preferred and which one they least preferred in the context of the experiment (''Assume that you will be working under *one* condition in a future session'').

RESULTS

Figure 1 shows cumulative competitive responses for eight pairs of subjects for 15 contests run under each of the six conditions. One pair of female subjects did not complete the experiment. One subject in that pair quit midway through the second session, stating that she was upset over not winning more often (she had won 2 of 14 completed contests). The cumulative number of responses shown for each pair in Figure 1 combine the pulls of both subjects during the contests. If one of the subjects stopped a contest, further pulls by either subject were not counted. For each pair, the cumulative number of responses under a given condition tended to be approximately linear or decelerating.

Conditions with proportional reward distributions produced the largest numbers of competitive responses across the 15 contests. Table 2 shows total number of competitive responses for each condition. For seven of the eight pairs, one of the proportional distributions produced 3%, 13%, 39%, 57%, 59%, 79%, and 106% more competitive responses than occurred under any condition with a 100%/0% or 67%/33% distribution. For the remaining pair (F-A), the 67%/33% distribution with pulls shown produced 6% more responses than did the proportional distribution with pulls shown. For six of the eight pairs (W-J, M-S, S-P, F-A, S-S, and L-A), rates in the proportional conditions were linear and high. For the other two pairs (K-E and R-A), rates decelerated. For six pairs (W-J, S-P, K-E, F-A, R-A, and S-S), one of the 100%/0% conditions produced the fewest competitive responses, typically with decelerating rates. For the 67%/33% conditions, rates were linear and high for three pairs (S-P, F-A, and L-A) and decelerating for the other five. As the

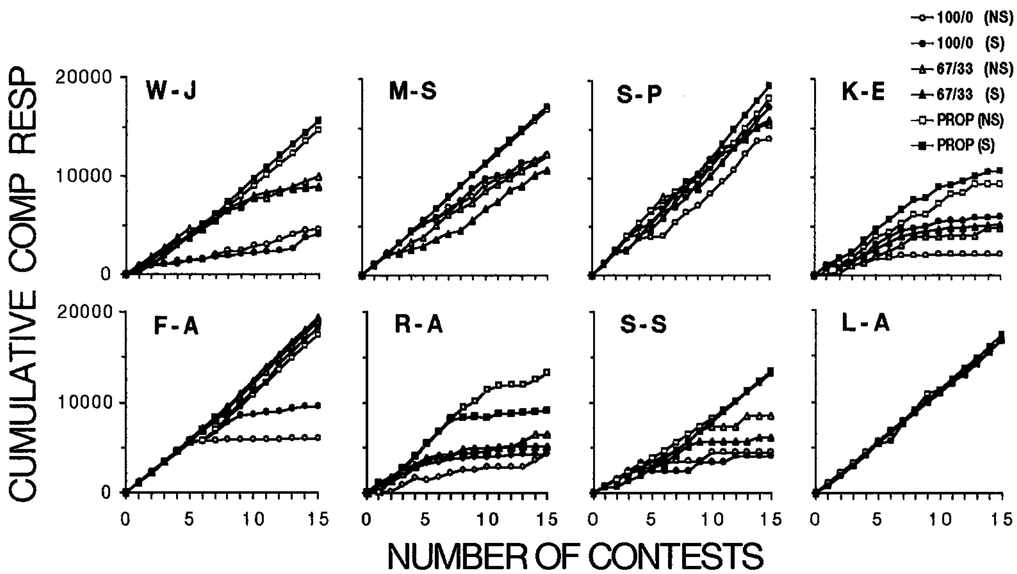

Fig. 1. Cumulative competitive responses by pair over all contests with fixed (100%/0% or 67%/33%) and proportional reward distributions. Conditions with feedback present (pulls shown) and absent (pulls not shown) are shown as S and NS, respectively.

number of decelerating records shows, initial effects of competitive conditions often differed markedly from later ones. The changes were apparent by the 10th contest, and often earlier, suggesting that rates for the last five contests approximate steady-state behavior.

Figure 2 describes the effect of performance feedback: showing (S) or not showing (NS) the number of pulls during the contests. For each distribution, the number of competitive responses in contests in which pulls were shown was divided by the number of competitive responses in all contests (with pulls shown and not shown). During the first five contests, showing or not showing pulls had little effect on a pair's responding, regardless of distribution. During the last 10 contests, showing or not showing pulls had more substantial effects on the responding of four of the eight pairs, with differences or changes greater than .20 for at least one of the distributions. For three of these pairs (F-A, S-S, and K-E), competitive rates were higher in the 100%/0% condition when pulls were shown. However, this difference occurred after responding had declined markedly, when losers were typically ending the contests. For R-A, competitive rates declined in all distributions when pulls were shown. Subjects in this pair eventually split the competitive earnings in the proportional condition with pulls shown. Of the first seven contests, all but the first were won by the same subject. In Contests 8 and 9, subjects made equal numbers of responses, with each subject earning 40 cents. In Contest 10, the previously winning subject responded at a high rate early and his opponent ended the contest, thus forcing earnings of 26 cents each. For each of the last five contests, subjects responded equally, making no more than 50 responses.

Because there was no clear effect of feedback (i.e., of showing or not showing pulls), the responses from the two conditions were combined in subsequent analyses. This step was also supported by an analysis of variance of the data. A 3 (Reward Distribution) × 2 (Feedback Condition) × 3 (Contest Block) repeated measures analysis of variance showed no significant main effect of feedback or interaction with feedback. The effect of reward distribution was significant, $F(2, 48) = 7.09$, $p < .05$, but the Contest Block × Reward Distribution interaction was not, $F(4, 96) = 2.32$, $p < .07$. However, with only the 100%/0% and proportional distributions compared, the Contest Block × Reward Distribution interaction was significant, $F(2, 64) = 3.84$, $p < .05$.

Figure 3 shows number of competitive re-

Table 2

Competitive responses (Contests 1–5, 6–10, 11–15, and total), proportion of contests completed, proportion of completed contests won and tied by the 2 subjects (A and B), proportion of competitive responses by winning subject (win proportion A or B) in completed contests, competitive earnings from completed contests for each subject (A and B), and stated preferences for each subject (1st, 6th choices A, B). S and NS indicate conditions with competitive pulls shown and not shown, respectively.

		Competitive responses				Proportion contests	Proportion wins		
Group	Distribution	1–5	6–10	11–15	Total	completed	A	B	Ties
W-J	100/0 (NS)	1,358	1,569	1,636	4,563	.20	1.00	.00	.00
(male)	100/0 (S)	1,427	789	1,787	4,003	.20	.67	.33	.00
	67/33 (NS)	4,596	3,141	2,160	9,897	.67	1.00	.00	.00
	67/33 (S)	3,706	4,234	923	8,863	.60	1.00	.00	.00
	Proportion (NS)	3,831	5,109	5,671	14,611	.87	.85	.08	.08
	Proportion (S)	4,046	5,597	5,907	15,550	.87	1.00	.00	.00
K-E	100/0 (NS)	1,750	361	11	2,122	.07	1.00	.00	.00
(male)	100/0 (S)	2,993	2,389	528	5,910	.20	.67	.33	.00
	67/33 (NS)	1,952	2,036	908	4,896	.40	1.00	.00	.00
	67/33 (S)	2,656	1,999	547	5,202	.33	1.00	.00	.00
	Proportion (NS)	3,903	3,349	2,056	9,308	.67	1.00	.00	.00
	Proportion (S)	4,688	4,275	1,609	10,572	.73	1.00	.00	.00
S-P	100/0 (NS)	3,869	4,478	5,631	13,978	.33	.40	.60	.00
(male)	100/0 (S)	5,218	5,800	6,209	17,227	.33	.80	.20	.00
	67/33 (NS)	6,673	5,217	3,640	15,530	.60	.22	.78	.00
	67/33 (S)	4,693	5,493	5,765	15,951	.27	.75	.25	.00
	Proportion (NS)	6,644	4,681	6,813	18,138	.73	.18	.55	.27
	Proportion (S)	5,359	6,522	7,607	19,488	.87	.08	.54	.38
M-S	100/0 (NS)	4,352	3,665	2,872	10,889	.47	.14	.86	.00
(female)	100/0 (S)	5,174	4,645	2,391	12,210	.40	.00	1.00	.00
	67/33 (NS)	3,811	4,775	3,753	12,339	.47	.29	.71	.00
	67/33 (S)	2,641	3,816	3,982	10,439	.27	.75	.25	.00
	Proportion (NS)	4,405	5,767	5,543	15,715	1.00	.13	.80	.07
	Proportion (S)	5,591	5,828	5,765	17,184	.93	.07	.29	.64
S-S	100/0 (NS)	3,301	1,185	31	4,517	.33	1.00	.00	.00
(female)	100/0 (S)	2,380	1,021	621	4,022	.20	1.00	.00	.00
	67/33 (NS)	3,414	3,918	1,167	8,499	.67	.90	.10	.00
	67/33 (S)	2,740	2,921	475	6,136	.53	1.00	.00	.00
	Proportion (NS)	3,816	4,433	5,226	13,475	1.00	.93	.07	.00
	Proportion (S)	2,769	5,132	5,343	13,244	1.00	.64	.07	.29
L-A	100/0 (NS)	5,602	5,492	5,754	16,848	1.00	1.00	.00	.00
(female)	100/0 (S)	5,410	5,508	5,736	16,654	1.00	1.00	.00	.00
	67/33 (NS)	5,551	5,557	5,720	16,828	1.00	1.00	.00	.00
	67/33 (S)	5,491	5,578	5,649	16,718	1.00	1.00	.00	.00
	Proportion (NS)	5,598	5,640	6,052	17,290	1.00	1.00	.00	.00
	Proportion (S)	5,386	5,895	5,991	17,272	1.00	1.00	.00	.00
F-A	100/0 (NS)	5,736	112	85	5,933	.33	.40	.60	.00
(female)	100/0 (S)	5,515	3,089	872	9,476	.20	.67	.33	.00
	67/33 (NS)	5,671	6,351	6,818	18,840	1.00	.33	.67	.00
	67/33 (S)	5,856	6,541	6,941	19,338	1.00	.47	.53	.00
	Proportion (NS)	5,723	5,137	6,580	17,440	.93	.14	.64	.21
	Proportion (S)	5,672	5,593	6,941	18,206	.93	.29	.50	.21
R-A	100/0 (NS)	1,730	1,135	1,462	4,327	.00	.00	.00	.00
(male)	100/0 (S)	3,240	704	324	4,268	.13	.50	.50	.00
	67/33 (NS)	3,563	1,399	1,457	6,419	.27	1.00	.00	.00
	67/33 (S)	3,859	713	588	5,160	.13	.67	.33	.00
	Proportion (NS)	5,393	5,988	1,823	13,204	.53	1.00	.00	.00
	Proportion (S)	5,462	3,241	360	9,063	.87	.31	.08	.62

Table 2

(*Extended*)

Win proportion	Competitive earnings A	Competitive earnings B	Stated preferences
.84 (A)	2.40	0.00	A, B: 6th
.54 (A)	1.60	0.80	
.70 (A)	5.40	2.60	
.61 (A)	4.86	2.34	
.53 (A)	5.57	4.83	
.56 (A)	5.78	4.62	A, B: 1st
.50 (A)	0.80	0.00	A, B: 6th
.53 (A)	1.60	0.80	
.80 (A)	3.24	1.56	
.67 (A)	2.70	1.30	
.61 (A)	4.93	3.07	A: 1st
.58 (A)	5.19	3.61	B: 1st
.52 (B)	1.60	2.40	A, B: 6th
.51 (A)	3.20	0.80	A: 1st
.51 (B)	2.90	4.30	
.51 (A)	1.88	1.32	
.51 (B)	4.26	4.54	
.51 (B)	5.09	5.31	B: 1st
.51 (B)	0.80	4.80	A: 6th
.51 (B)	0.00	4.80	B: 6th
.51 (B)	2.38	3.22	
.50 (B)	1.88	1.32	
.51 (B)	5.83	6.17	B: 1st
.50 (B)	5.54	5.66	A: 1st
.60 (A)	4.00	0.00	B: 6th
.55 (A)	2.40	0.00	A: 6th
.65 (A)	5.12	2.88	
.56 (A)	4.32	2.08	
.56 (A)	6.74	5.26	
.54 (A)	6.06	5.14	A, B: 1st
.58 (A)	12.00	0.00	
.57 (A)	12.00	0.00	A: 1st; B: 6th
.57 (A)	8.10	3.90	
.56 (A)	8.10	3.90	
.57 (A)	6.80	5.20	A: 6th
.56 (A)	6.71	5.29	B: 1st
.50 (A)	1.60	2.40	A: 6th
.52 (A)	1.60	0.80	B: 6th
.52 (B)	5.30	6.70	B: 1st
.50 (B)	5.86	6.14	A: 1st
.52 (B)	5.33	5.87	
.51 (B)	5.50	5.70	
	0.00	0.00	A, B: 6th
.80 (A)	0.80	0.80	
.68 (A)	2.16	1.04	
.68 (A)	1.08	0.52	
.55 (A)	3.53	2.87	
.51 (A)	5.33	5.07	A, B: 1st

sponses across five-contest blocks for the three kinds of reward distributions. For the final block of contests (11 through 15), response rates for the proportional distribution were equal to or greater than those for the other distributions for all pairs except F-A. Only for the proportional distribution were response rates in the final block typically as high or higher than rates in earlier blocks.

The distributions differed greatly with regard to the proportion of all contests completed by the pairs (contests in which neither subject made the stop response). Figure 4 shows the proportions for each of the reward distributions, and Table 2 shows the proportions for each of the six conditions. The proportion was 1.0 if all of the 2-min contests were completed. As Figure 4 shows, proportions were typically highest for the proportional distribution, when most contests were completed, and lowest for the 100%/0% distribution, when most were stopped, many within the first several seconds.

The proportion of total competitive responses made by the winning subject differed among pairs and was also a function of condition. Figure 5 shows the winning proportions for each reward distribution for completed contests. Table 2 shows the winning proportions and the subject who won for each of the six conditions. The winning proportions for three pairs (S-P, M-S, and F-A) were close to equality (.5). Overall, the fixed reward distributions tended to produce the highest winning proportions—subjects were more unequal in their responding. For each reward distribution, winning proportion and number of competitive responses were negatively correlated across pairs. The correlation coefficients (Pearson r) were $-.44$ for the 100%/0% distribution, $-.83$ for the 67%/33% distribution, and $-.62$ for the proportional distribution.

In response to the postexperiment questions, none of the subjects said he or she knew or talked to the partner. Table 2 shows most preferred (1st) and least preferred (6th) choices among the six conditions (subjects were asked only for these extremes). One of the proportional distributions was the first choice by 12 of the 16 subjects; 10 of these preferred that pulls be shown. One of the 100%/0% distributions was the last

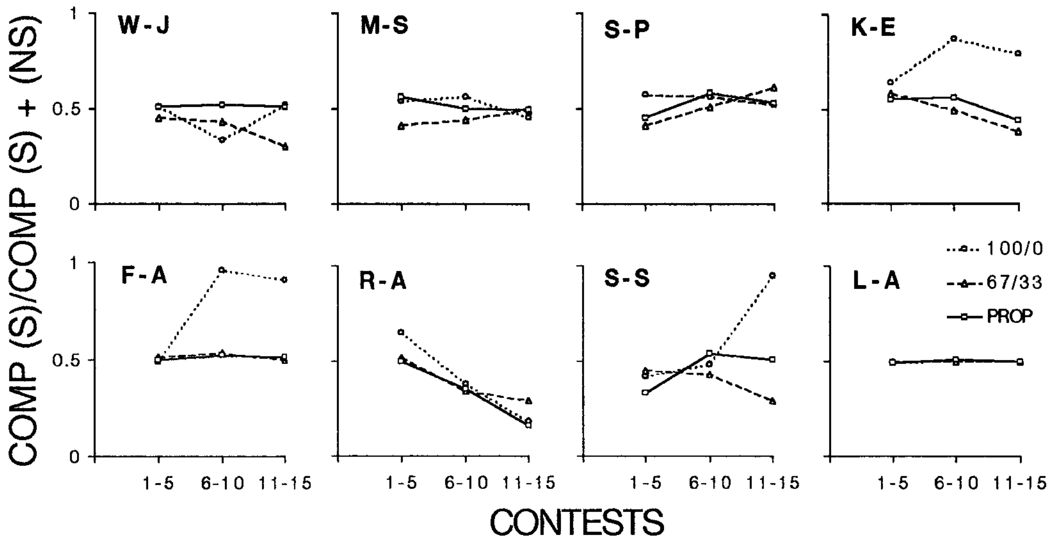

Fig. 2. Index showing the effect of feedback. Total number of competitive responses when feedback about number of pulls was shown (S) is expressed as a proportion of the sum of competitive responses when pulls were shown and not shown (S + NS). Proportions are shown separately for fixed (100%/0% or 67%/33%) and proportional reward distributions. Data are means for Contests 1–5, 6–10, and 11–15. Means greater than .5 indicate a higher proportion of competitive responses in contests with pulls shown (feedback given).

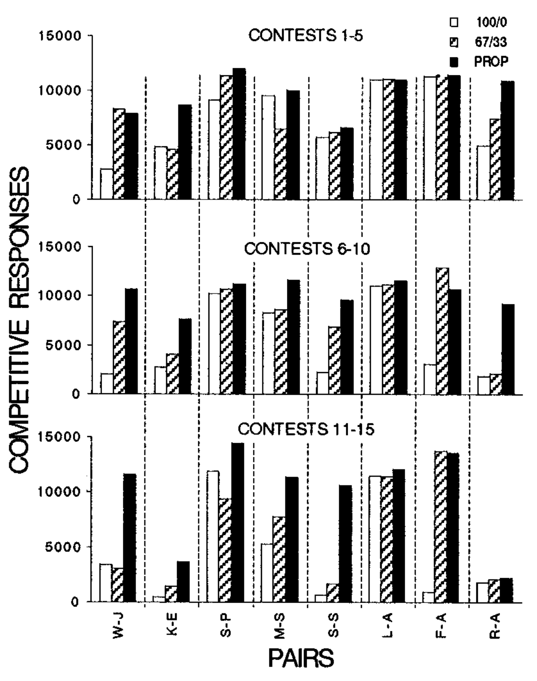

Fig. 3. Mean number of competitive responses by pair in Contests 1–5, 6–10, and 11–15 with fixed (100%/0% or 67%/33%) and proportional reward distributions (contests with pulls shown and not shown are combined).

choice of 15 subjects; 11 of these least preferred that pulls not be shown. Most choices, particularly the most preferred, were highly correlated with condition earnings.

DISCUSSION

Type of reward distribution had a substantial effect on the number of competitive responses for most pairs of competitors. Basing the reward distribution on the relative performances of the competitors (i.e., a proportional distribution) was clearly superior to using either of two fixed distributions in the total number of responses produced over repeated contests. The factor most responsible for differences in response totals among distributions was whether or not contests were stopped and when. Proportional distributions typically produced responding throughout each contest, with subjects rarely stopping contests. For fixed distributions (particularly 100%/0%), responding typically occurred only in the first portion of each contest, with losing subjects terminating contests early.

Performance differences produced by the distributions can be interpreted in terms of the resulting schedules of consequences for the individual competitors. The defining

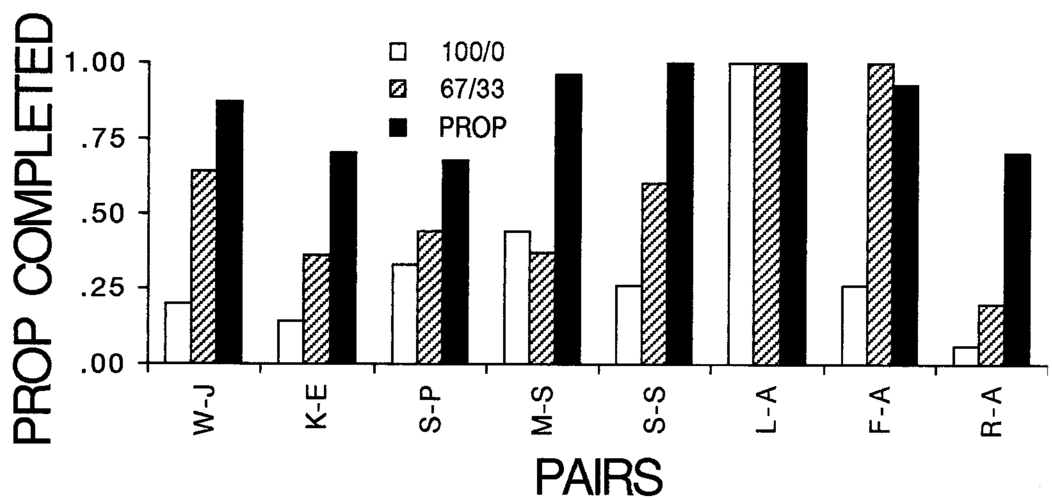

Fig. 4. Proportion of contests completed with fixed (100%/0% or 67%/33%) and proportional reward distributions (contests with pulls shown and not shown are combined).

characteristic of a proportional distribution, matching reinforcer and response proportions, makes all responding for each individual consequential (assuming that both subjects respond). With fixed distributions, the relation between responding and reinforcement depends on both the reward distribution and the difference between competitors' response rates during the contest. For the 100%/0% distribution, reinforcement schedules include continuous reinforcement and nonreinforcement if 1 subject wins consistently and intermittent reinforcement if winners alternate to any degree. For the 67%/33% distribution, reinforcement is continuous, with variability in reward size if winners alternate. The smaller portion of the competitive reward is contingent only on remaining in the contest (allowing the possibility of further responding).

As competitors win or lose over a series of contests with fixed distributions, a combination of current response rates and cumulative differences in response totals should become discriminative of the probability of receiving the larger reinforcer. Stimuli that show an increasing response advantage (or a decreasing disadvantage) relative to the op-

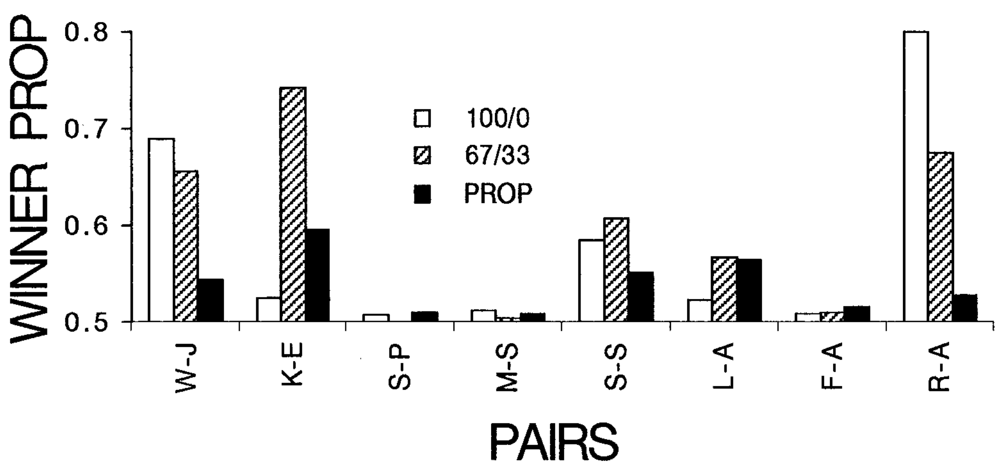

Fig. 5. Proportion of competitive responses made by the winning subject in completed contests with fixed (100%/0% or 67%/33%) and proportional reward distributions (contests with pulls shown and not shown are combined).

ponent should come to signal an increasing probability of reinforcement for responding. But response advantages or disadvantages that are insurmountable given the time remaining in the contest should come to signal nonreinforcement for additional responding by either competitor. In the first few contests, such differentials should reduce responding in the latter part of each contest, but they should eventually reduce responding early in the contests as well if performance differences are large and stable.

In contrast to the large effects of distribution type on response patterns, performance feedback (showing or not showing pulls) had, at most, a small, selective effect of uncertain reliability. Two-minute contests were used in this study to maximize frequency of exposure to the various distributions, but the contests' short length probably minimized differences between the two feedback conditions. With performance feedback given at the end of all contests and provided continuously during half the contests, performance information accumulated rapidly and was most likely used similarly across conditions. This aspect of the study probably hastened the decline in responding across contests with the 100%/0% distribution. If that distribution alone had been used repeatedly, changes would probably have occurred later than was the case here.

All pairs of subjects showed at least some sensitivity to the different contingencies. By the end of the experiment, all pairs but one (L-A) were responding markedly less often than at the beginning under at least one of the conditions, and even this pair responded more often with proportional distributions. This sensitivity was a product of both the reward distributions and the option of terminating the contest. The presence of this option had two purposes. It is congruent with a choice among responses commonly found in everyday settings, and it maintains the participation of unsuccessful competitors when they are studied over a series of sessions. Subjects in a terminated contest each earned one third of the 80 cents available per contest. This difference made competition more profitable than stopping the contest, despite substantial differences between subjects in responding and winning. For the proportional distribution, competition was the more profitable alternative provided that a subject made more than one third of the total responses. For the 100%/0% distribution, competition was more profitable than stopping the contest if a subject won more than one third of the time. For the 67%/33% distribution, competition was more profitable than stopping the contest if a subject won at least one contest (the losing competitive share and the amount received from a terminated contest were the same size). With these amounts identical, the major consequence of withdrawal was the elimination of the reward inequities in the competitive distribution. Withdrawal from competition occurred frequently in all but two pairs with the 67%/33% distribution, consistent with evidence from other settings showing that reward inequities are aversive (Marwell & Schmitt, 1975; Schmitt & Marwell, 1972). If the reward from stopping the contest had been smaller than the lowest competitive reward, the likely result would have been fewer contests stopped but not necessarily more responding by the loser.

Over repeated contests, the fewest competitive responses were made by pairs with the largest disparities in responses (analogous to ''skill'') and wins. Differences between competitors in knob-pulling rates emerged early, and the same competitor in each pair typically won most contests, regardless of condition. In everyday situations, many tasks generate performances that are variable over time, especially when chance plays a role in success. Such variability should promote greater competition and delay withdrawal from contests by the losers.

Although the superiority of proportional over fixed distributions in generating high response output was clear, implementation of the optimal reward distribution is often problematic. Proportional distributions require that reinforcer amount be readily quantified, and this may be difficult or impossible if reinforcers are prizes such merchandise, trips, or promotions. Also, proportional distributions require quantification of competitors' responses (e.g., the number of responses during some time period or the time required to complete some task), not just their ranking. Doing so may be difficult or costly. If a proportional distribution is not practical, the present findings recommend the more equal of the fixed distributions, one with a payoff for the loser. Further, the findings suggest that choice of reward distribution is most consequential when contests with the same competitors are repeated a number of times, a situation that allows consistent performance differences to emerge. For a single, short contest involving strangers, the type of the reward distribution is likely to make little difference. Although numerous repeated contests with the same competitors may not be common in everyday settings, it is common for competitors to have prior information about performance differences, through previous observations, reputation, or records. If so, the nature of the reward distribution should also be important in early contests and may determine whether the contest is entered at all. Finally, caution should be exercised in extrapolating the present findings beyond two-person groups. As groups increase in size, the largest reward also increases (assuming that average reinforcer amounts for each competitor remain constant), and a much greater variety of reward distributions becomes possible (Schmitt, 1986). These distributions will produce their own characteristic patterns of response and withdrawal rates (Schmitt, 1976).

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